



Design & Flight Testing of a Mortar Deployed Video Imager

4/10/01, NDIA PRES.

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JOHN MCLAUGHLIN / JAMES SPANGLER - ELECTRONICS DESIGN / FAB. / ASSEMBLY & TESTING.

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CHARLIE MITCHELL - H/W FABRICATION

ERIC IRWIN / ED BUKOWSKI - BATTERY CONDITIONING SUPPORT

TOM HARKINS - IMAGE ANALYSIS

SAM PEREZ / DIANE WAGNER / EUGENE SCHLENK - PM MORTAR SYSTEMS, ARDEC - MORTAR PARTS, DWGS, & INFO.

Design & Flight Testing of a Mortar Deployed Video Imager

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- **OBJECTIVES:** DESIGN & DEMONSTRATE A GUN-HARDENED, “WIRELESS”, DIGITALLY-ENCRYPTABLE, IMAGER SYSTEM (<\$10k/imager)
- **SUPPORTS:** ARDEC QUICKLOOK STO.
- **PLAN:** APPLY COTS VIDEO AND XMTR TECHNOLOGIES & INTEGRATE INTO A MODIFIED XM930 120mm MORTAR SUBMUNITION.
- **CONCLUSIONS:** SUCCESSFULLY FLIGHT-TESTED IMAGER MORTAR TO ~2000 G’S, PCZ #1.
- **LESSONS LEARNED:** IMAGERY MUST BE ANALYZED TO DETERMINE USAGE, TLE, BDA, etc. & TO DETERMINE REQ’D. IMPROVEMENTS.

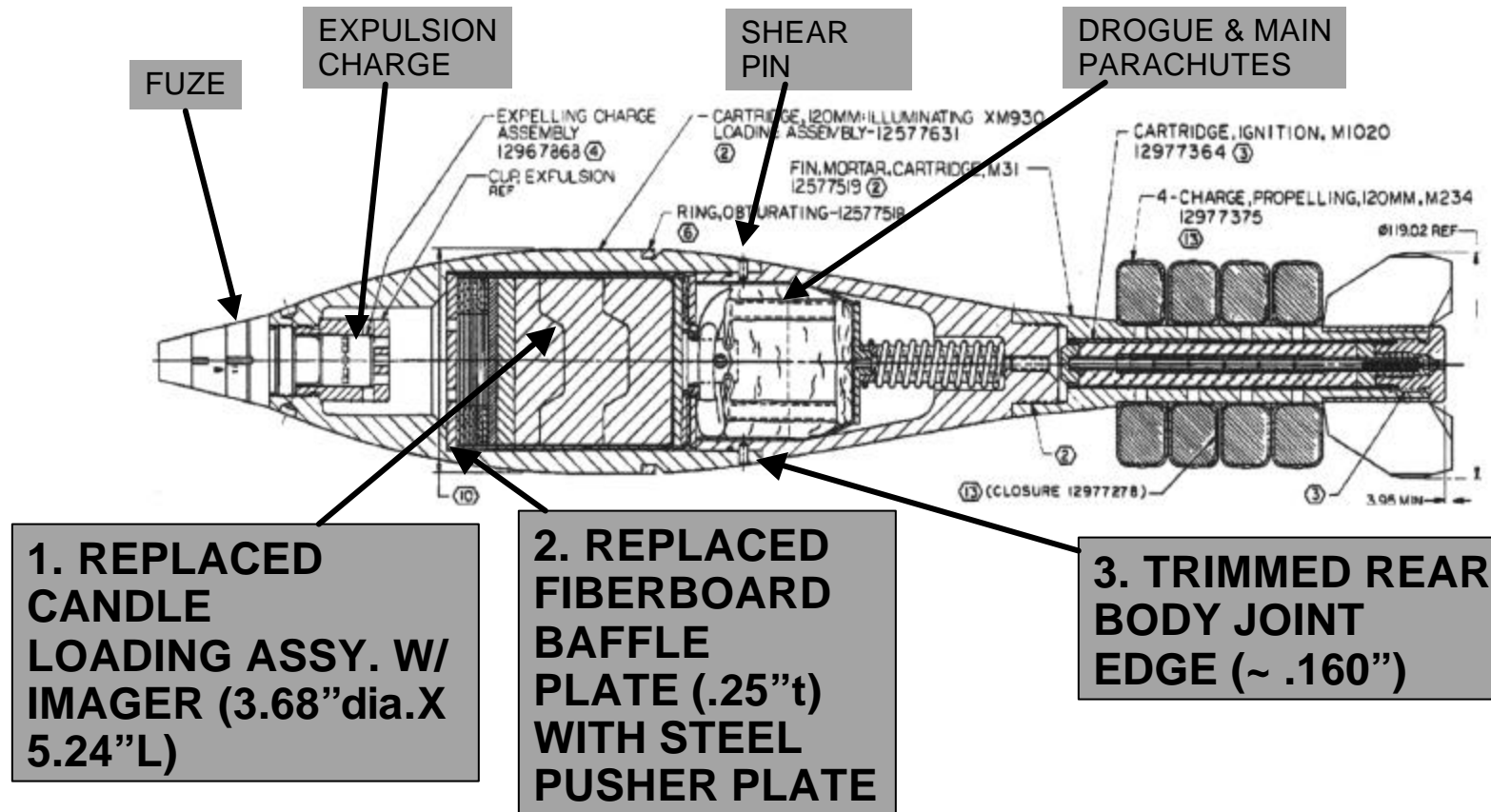


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FLIGHT TEST PLATFORM – REQ.'D MODS.



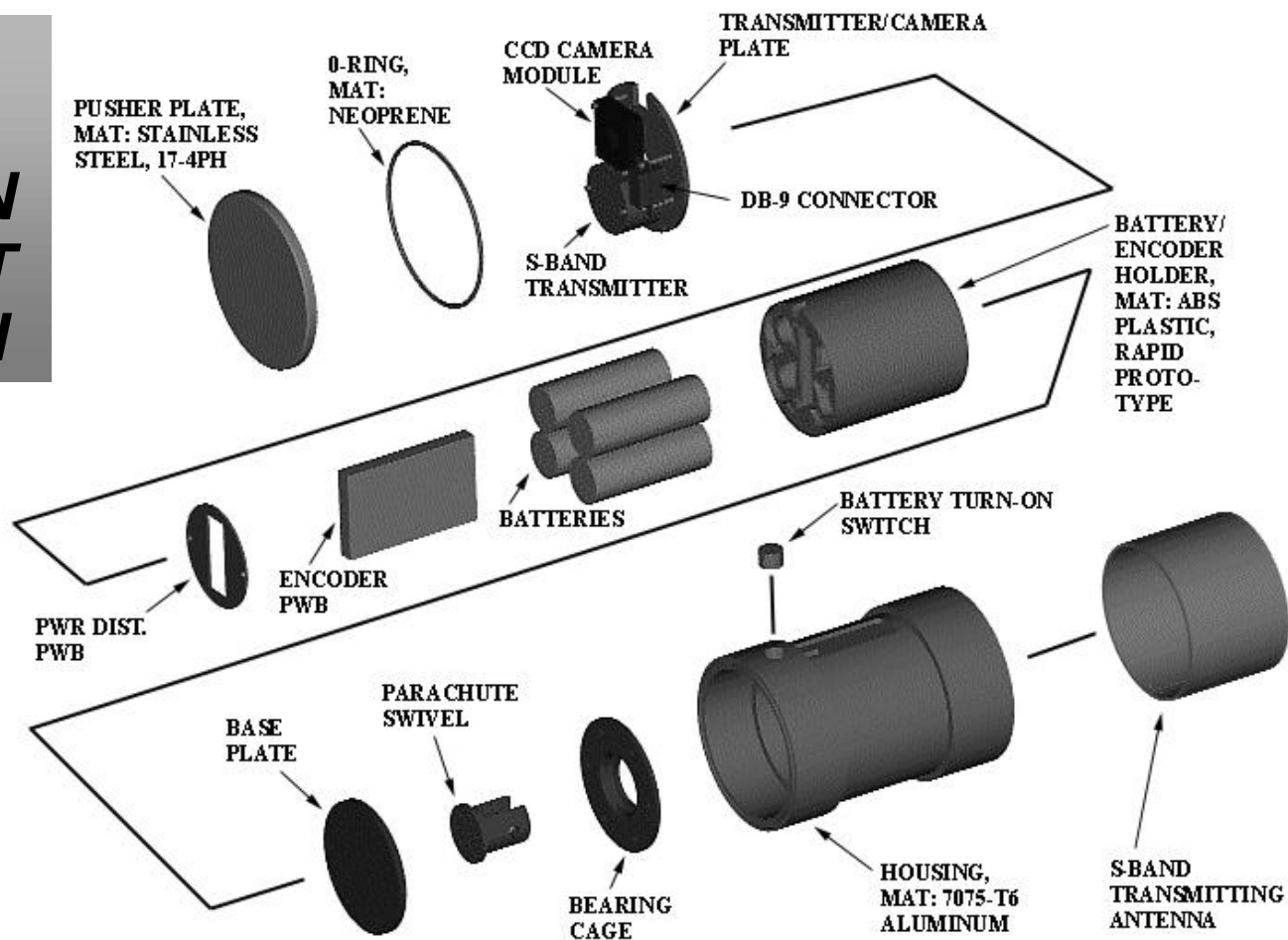


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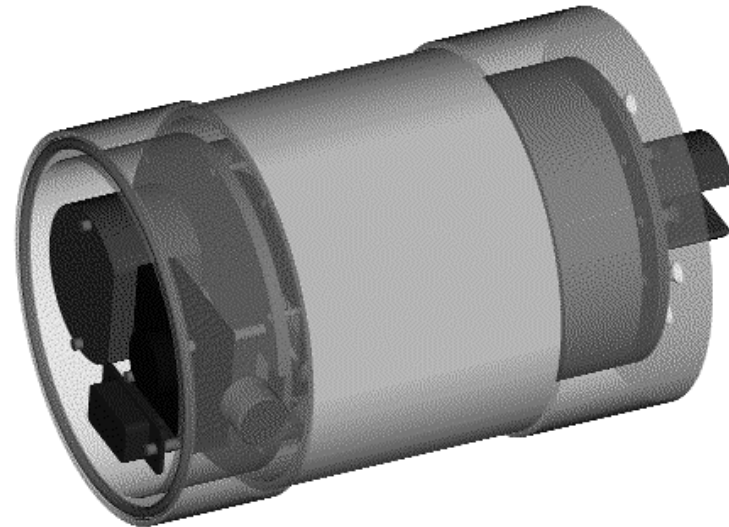
IMAGER SUB- MUNITION CONCEPT & DESIGN



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<u>IMAGER BOM (NON-PROD. VERSION)</u>	<u>\$</u>
COTS CCD CAMERA	120
COTS VIDEO COMPRESSION ENCODER	2880
COTS XMTR, S-BAND, HI-G Q'D.	4000
COTS ANTENNA, S-BAND	1525
<u>COTS BATTERIES, NICAD</u>	<u>50</u>
PER UNIT COST (W/O NRE & LABOR COSTS)	8575



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KEY DESIGN FEATURES....

**O-RING SEAL
FOR INTERNAL
EXPULSION GAS
RESISTANCE**

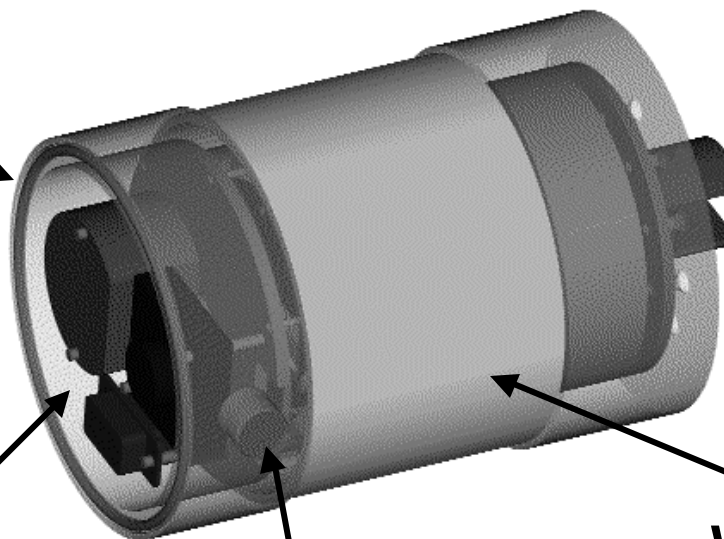
**IMAGER
FOV**

**ENCAPSULATE
INTERIOR VOL.
& COMPS. TO
SHOCK-HARDEN**

**THRU-MORTAR-BODY
MAN. TURN-ON
SWITCH**

**INTERFACE
TO EXISTING
PARACHUTE**

**INTEGRATE
WRAP-AROUND
ANTENNA**



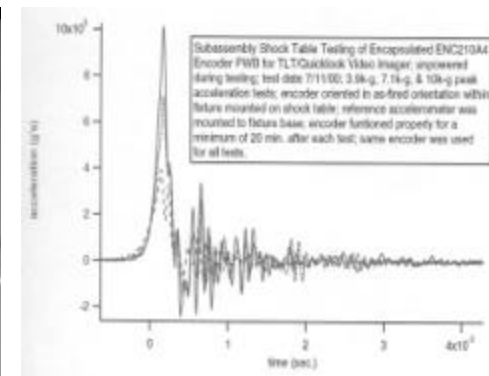
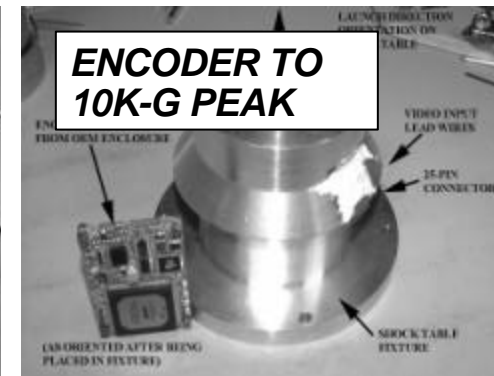
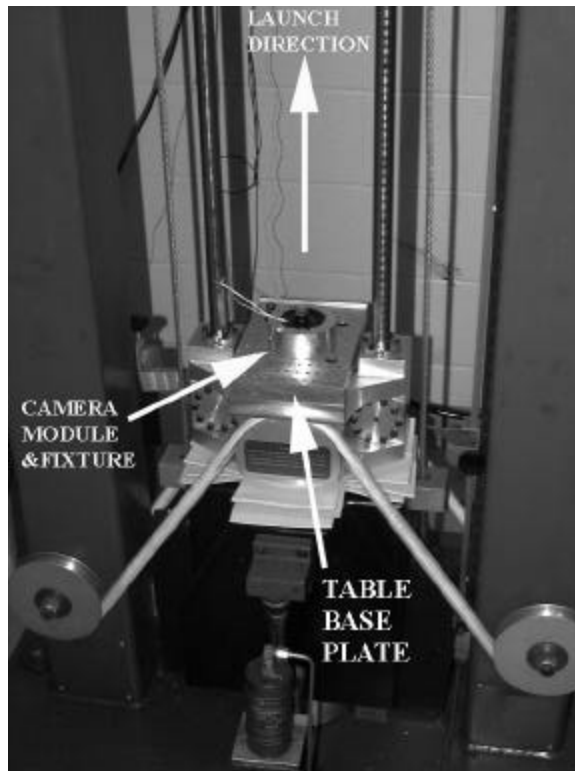


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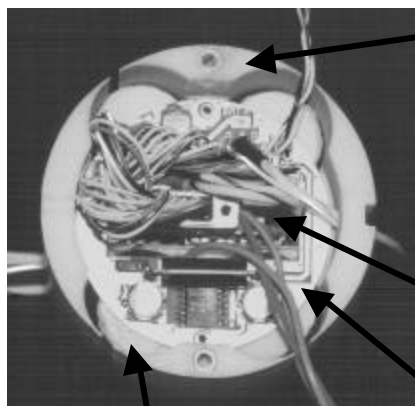
GROUND SHOCK TABLE TESTING OF IMAGER COMPONENTS...



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ASSEMBLE....



**ABS PLASTIC RP
BATT+ENCD'R+
PWR BOARD
HOLDER
(used CAE art-to-
part technologies,
FDM)**

**ENCD'R BRD
(OEM as is)**

PWR BRD

**4X NICAD BATTS,
(20min. total discharge time)**

ENCAPSULATE....





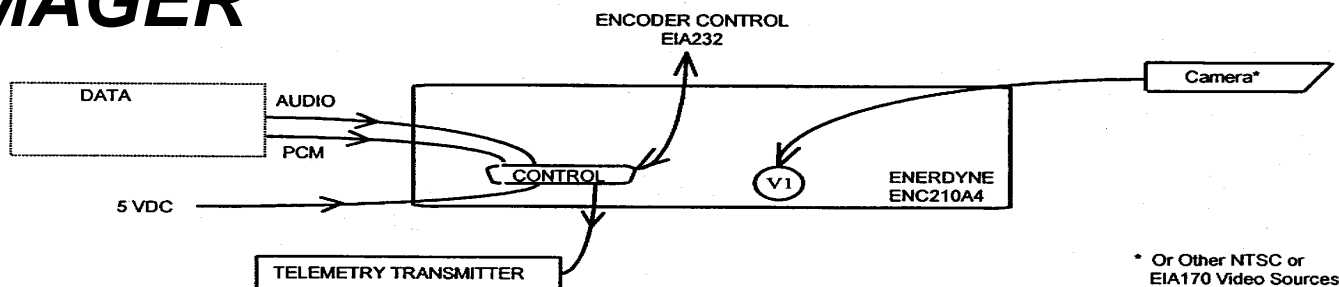
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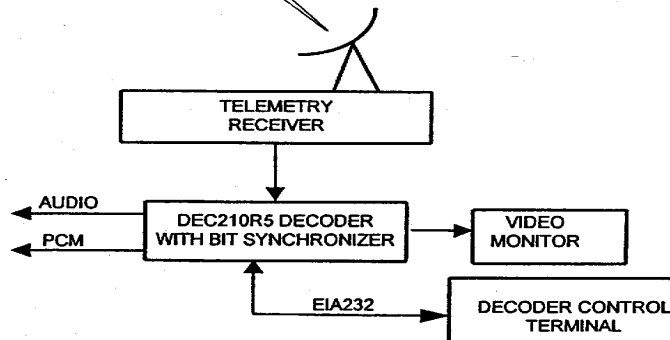
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IMAGER SYSTEM

IMAGER



GROUND-STATION



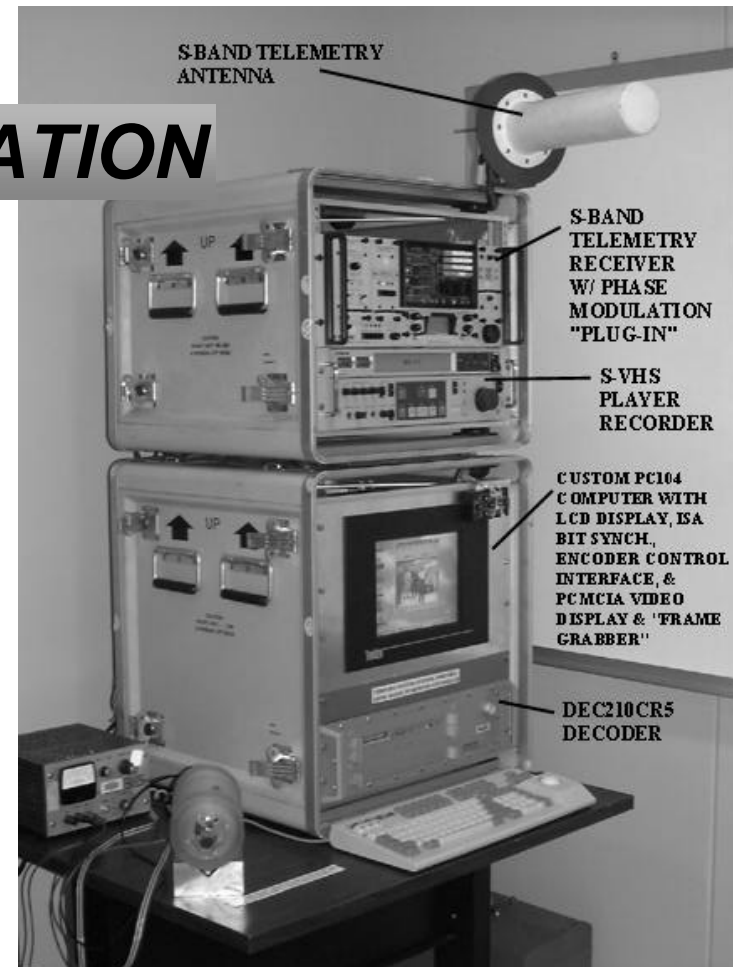


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IMAGER GROUND STATION





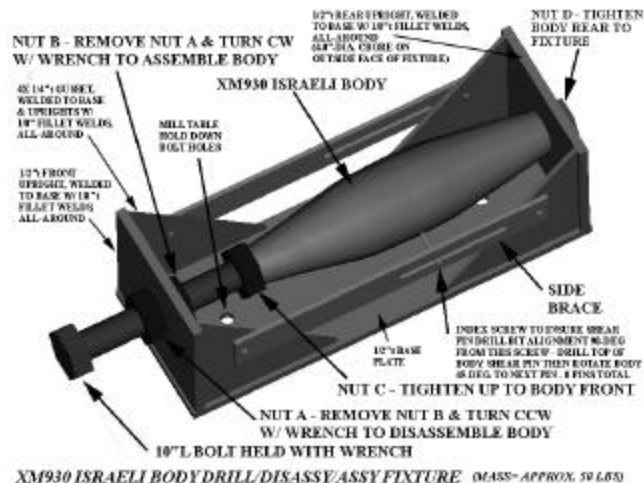
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DESIGNED & BUILT A LOW-COST, IN-LAB MORTAR BODY ASSEMBLY FIXTURE

- FOR BATTERY TURN-ON SW. PORT INSTALL.
- IMAGER INSTALLATION
- MORTAR BODY SHEAR PIN INSERTION



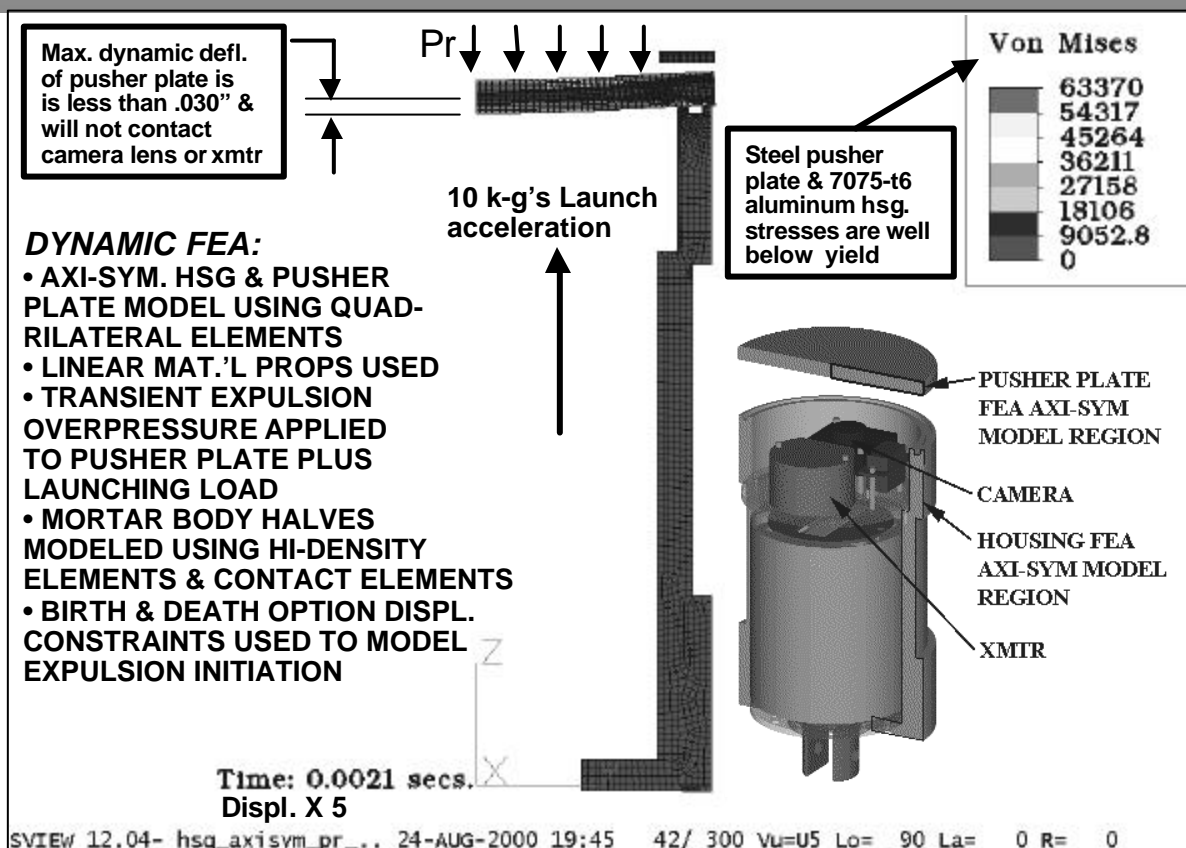


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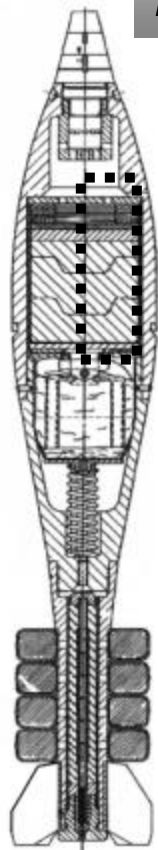
VERIFIED HSG. & PLATE STRUCTURAL INTEGRITY AND MORTAR EXPULSION DYNAMICS WITH FEA



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FEA ANIMATION...EXPULSION



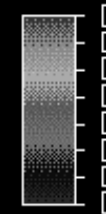
Structural Dynamic FEA of Axis-Sym. Imager Hsg. & Pusher Plate

Time: 0 secs.

Expulsion Pressure Load Case

Displacements X1

von Mises





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FLIGHT TESTED MOCKUP IMAGER ROUNDS

- INSURED EXPULSION & CHUTE DEPLOYMENT
- VERIFIED INTEGRITY OF HOUSING & FEA PREDICTIONS
- VERIFIED INTEGRITY ANTENNA
- VERIFIED O-RING SEAL
- VERIFIED PUSHER PLATE DYNAMICS



***120mm MORTARS...WARMERS
& MOCKUP IMAGER ROUND***

RECOVERED MORTAR BODY HALVES AND MOCKUP IMAGER



RECOVERED MOCKUP IMAGER



MINIMAL
RESIDUE
DEPOSITED
BY EXPUL.
CHARGE GAS
BLOW-BY...
CAMERA LENS
SHOULD BE
O.K.

CONTACT PINS
WERE NOT
CONTACTED
BY PUSHER
PLATE DURING
EXPULSION...
CAMERA & XMTR
SHOULD BE O.K.

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FLIGHT TESTING OF IMAGER MORTAR ROUND

- **PROVED IMAGER ROBUSTNESS TO TYPICAL MORTAR GUN-LAUNCHING LOADS (1500-3000 g's)...MINOR ANTENNA DAMAGE SUSTAINED IN SHOT**
- **IMAGER RECOVERED AND WAS REUSEABLE**
- **5 FR/SEC (@1.25MBITS/SEC.) ACQUIRED FOR 90 SEC. DECENT FROM EXPULSION @ 1400' ALTITUDE; INITIAL CAMERA FOV @ EXPULSION = 1616' x 1553', i.e. ~ 1m x 1m = 1 pixel**

20sec. of video from imager



***20sec. of video of decending
imager from camcorder on
ground***

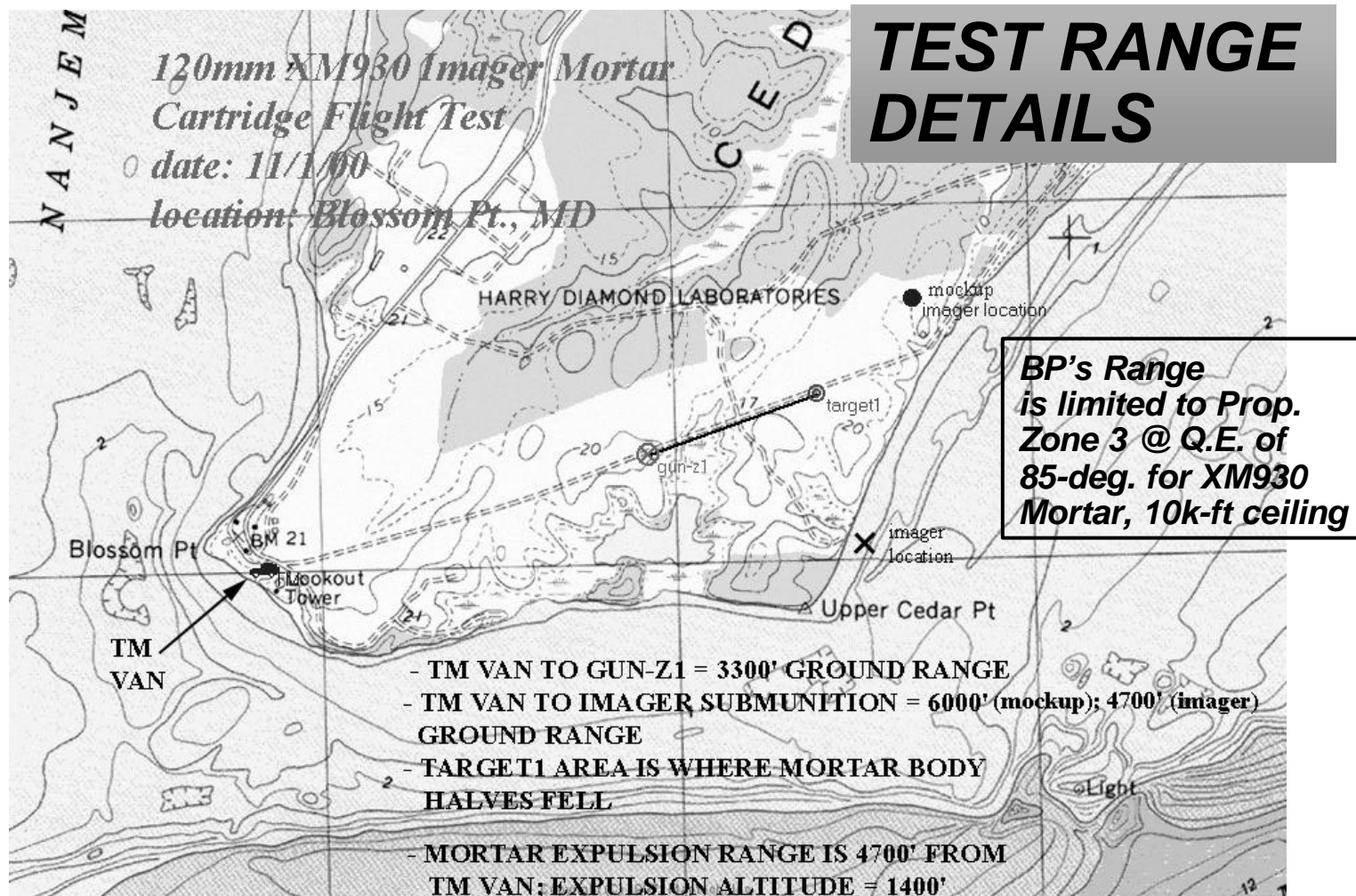




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SUMMARY

- **120mm MORTAR IMAGER CONCEPT PROVEN**
- **IMAGER GUN-HARDENED TO ~2000 gs**
- **IMAGER LESSONS LEARNED & FUTURE...**
 - **IMAGE QUALITY & USE MUST BE ADDRESSED**
 - **ANTENNA RECEPTION ISSUES [VIDEO DROP-OUTS] MUST BE ADDRESSED**
 - **INTEGRATE NEW HSTSS XMTR, INERTIAL SENSORS, SIG. COND., ADDITIONAL PCM ENCODER, NEW BATTERY, & GPS REC'R...SENSORS TELL WHERE IMAGER IS LOOKING**
 - **ADDITION OF INTERNAL G-SWITCH TURN-ON FEATURE; REDUCES BATTERY VOL., ELIMINATES GUNNER TASK.**